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FROZEN BLOOD SHIPPING

Dailey W. McPeak, et al

Army Medical Research Laboratory

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FROZEN BLOOD SHIPPING  
(Progress Report)

by

Dailey W. McPeak

and

COL Frank R. Camp, Jr., MSC

US ARMY MEDICAL RESEARCH LABORATORY  
Fort Knox, Kentucky 40121

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Military Blood Banking:  
Preservation Methods--Liquid and Frozen--and Logistics  
Work Unit No. 155  
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The purpose of this report is to recommend shipping containers and packaging techniques designed to provide optimum protection for frozen blood during long distance shipping. Data presented prescribe packaging techniques that will afford ample protection from temperature fluctuation for frozen blood when properly packed in designated shipping containers. The recommendation relates to shipping containers presently available in the military supply system. Further (cont)		

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studies are being made in designing and fabricating special transport boxes with the appropriate packing procedures that will enhance the position of blood banking logistics.

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USAMRL REPORT NO. 1,084  
DA PROJECT NO. 3A162110A821

### ABSTRACT

#### FROZEN BLOOD SHIPPING

#### OBJECTIVE

To recommend a shipping container with packaging techniques designed to provide optimum protection for frozen blood during long distance shipping.

#### RESULTS

Data presented prescribe packaging techniques that will afford ample protection from temperature fluctuation for frozen blood when properly packed in a designated shipping container.

#### CONCLUSION

The recommendation contained herein relates to a shipping container presently available in the military supply system. Shipping boxes designed specifically for frozen blood are under study.

## FROZEN BLOOD SHIPPING

### INTRODUCTION

Since the earliest recorded history man has displayed an unremitting interest regarding alteration of the normal process of aging. Until recently, little work had been directed toward preservation of living tissues at low temperatures in an attempt to retard aging. Work by Luyet and Gehenlo (2) and Polge *et al* (4) marks the general beginning of modern studies along these lines. Observations by the latter regarding the effects of freezing on bull sperm led to a study investigating the possible preservation of blood at temperatures below freezing. A review of current literature will reveal a comprehensive treatise indicating the success, practicability, and clinical acceptance of blood which has been frozen. Preservation of human blood in the frozen state has now advanced from the experimental stage to clinical utilization. Both the Army and the Navy, including The Blood Bank Center at the US Army Medical Research Laboratory, Fort Knox, Kentucky, have established frozen blood banks. During the recent Southeast Asia conflict, the Navy created an experimental frozen blood bank at the Naval Station Hospital, Da Nang, South Vietnam.

One of the primary obstacles to frozen blood preservation has been hemolysis upon thawing due to osmotic stress on the red cell membrane. The formation of extracellular ice crystals causes dehydration of cells and increases solute concentration in the unfrozen liquid, rendering the cells less durable.

The basic technique, designed to circumvent these problems while preserving cell integrity during the freeze-thaw process, has been the addition of glycerol as an agent to mitigate cell destruction by reducing the mole fraction of water available for crystallization. The additive may be used either in high concentrations of 40 to 50% in conjunction with slow freezing, down to  $-80^{\circ}\text{C}$ , or low concentration with rapid freezing using liquid nitrogen (1).

A storage temperature of  $-80^{\circ}\text{C}$  is adequate for periods in excess of ten years (3). On the basis of *in vitro* assays, a temperature above  $-60^{\circ}\text{C}$  is unsatisfactory for storage in excess of a few weeks. Fluctuations in storage temperature of  $10^{\circ}\text{C}$  above or below  $-80^{\circ}\text{C}$  have no adverse effect.

The cost is higher when preserving red cells by the freezing method, but the attributes that make it superior are the concomitant prolonged storage characteristic, coupled with selected clinical situations that require rare blood types. Hence, along with the growing interest in freezing blood comes the need for special shipping containers and packaging techniques which will afford the added protection necessary for proper maintenance of the blood during long distance shipping. In view

of the fact that facilities for freezing blood will necessarily be more restrictive, the number of installations capable of supplying frozen blood will be few and long distance transporting will become commonplace. Therefore, the purpose of this report is to establish guidelines leading toward the standardization of containers and packaging techniques for frozen blood. Data from studies conducted at room temperature are presented.

#### MATERIALS AND METHODS

Technical documentation for blood shipping container, Federal Stock Number (FSN) 8115-935-9761 (Fig. 1), is extended for use in transporting frozen blood. Seven Fenwal Cryocyte packs fabricated from heavy cardboard measuring 9 x 14-1/2 inches were used as the envelopes for the Fenwal plastic bags which contained the simulated blood. Aluminum canisters of the approximate size which afford a more rapid heat transfer are also available. The paper carton selected for this test is much less expensive than the metal holder and, consequently, more practicable for



Fig. 1. Blood shipping container, FSN 8115-935-9761, manufactured by Life-Like Products, Inc., Baltimore, Maryland.



use as an expendable item--an important prerequisite for military shipping purposes. Utilizing the geometry of the transport container, seven cartons of blood were considered to be the ideal load per box. The cartons were placed diagonally into the shipping container with the narrow edges exposed to the outside of the box, thus allowing the larger surface area of the blood cartons contact with the dry ice refrigerant.

Approximately 16 hours prior to the test, the cartons were placed in a Harris low temperature, Model 19L-DR freezer, designed to maintain a temperature of  $-85^{\circ}\text{C}$ . Transferring the blood from the freezer to the shipping container was considered to be the most critical step involved in the packaging technique. A concentrated effort was made to effect the transfer in the minimum amount of time, thus avoiding undue exposure to the higher ambient temperature. Thirty pounds of dry ice were packed in such a manner as to encase the blood cartons. Pellet dry ice was used because it affords greater cooling qualities than does the block type (Fig. 2). A Yellow Springs, Model 42SL Tele-thermometer was

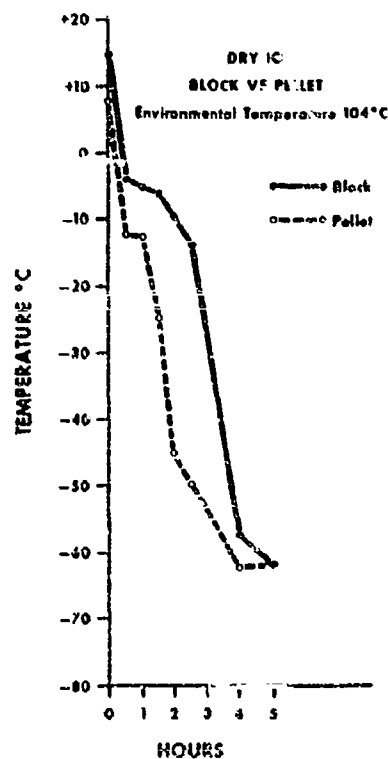


Fig. 2. Pellet ice vs block ice--curve.

utilized for monitoring the temperature. The temperature sensor was enclosed in the bag containing the blood substitute (Fig. 3).



Fig. 3. Frozen blood carton and blood container.

#### RESULTS AND DISCUSSION

Five hours after the experiment was begun, the temperature remained below  $-80^{\circ}\text{C}$ , which was beyond the range of the measuring instrument. The fact that the low temperature produced by the freezer was being maintained reflected most favorably on the packaging technique used.

Meryman and Hornblower (3) found from *in vitro* assays of cell potassium that temperatures above  $-60^{\circ}\text{C}$  are unsatisfactory for storage in excess of a few weeks. In addition, other work indicates that fluctuations in storage temperature of  $-80^{\circ}\text{C} \pm 10^{\circ}\text{C}$  have no adverse effects (1).

The initial temperature measurement following the transfer and packing phase of the test was  $-70^{\circ}\text{C}$ . The temperature was maintained below  $-60^{\circ}\text{C}$  for approximately 31 hours (Fig. 4). Work by Vaieri *et al* (5) indicates that blood stored above  $-60^{\circ}\text{C}$  is unsatisfactory if not used within a few weeks.

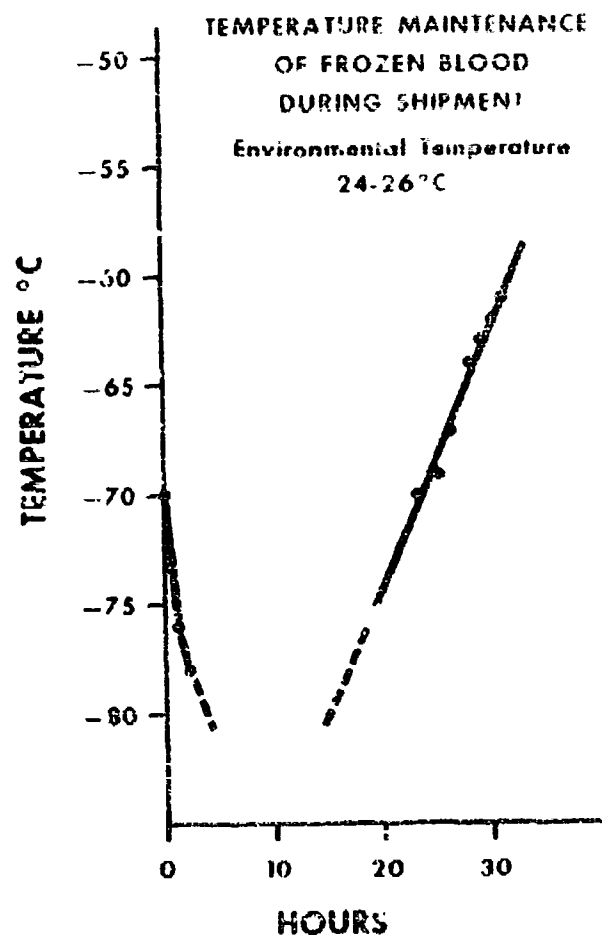


Fig. 4. Temperature curve of frozen blood.

#### SUMMARY

Frozen blood, although a relatively new field in blood banking, is currently commanding much attention. A look into the history of blood banks repeatedly reveals developments in the processing laboratory and clinical research far exceeding those in the logistics branch. Presently, the lack of specific techniques describing proper packaging of frozen blood for long distance shipping is no exception to past history. Effective techniques, utilizing designated shipping containers, primarily designed for other purposes, are presented herein. Further studies are being made in designing and fabricating special transport boxes with the appropriate packing procedures that will enhance the position of blood banking logistics.

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